

REPORT ON THE INTERNATIONAL WORKSHOP ON STRONG-MOTION
EARTHQUAKE INSTRUMENT ARRAYS

W. D. IWAN^I

SUMMARY

As a result of recommendations made during the Sixth World Conference on Earthquake Engineering, the International Association for Earthquake Engineering convened an International Workshop on Strong Motion Earthquake Instrument Arrays in May of 1978. The goal of the Workshop was to develop a workable plan for the possible future deployment of dense strong-motion arrays with primary emphasis on ground motion studies. This paper is a report on the Workshop and the status of the implementation of its recommendations.

INTRODUCTION

It is generally agreed that there is an urgent need for a better understanding of the nature of the strong ground motion resulting from earthquakes. This involves an understanding of each of the individual factors which affect the character of ground motion including; the properties of the source mechanism, the transmission characteristics of the wave propagation path and the effects of local topographic and soil conditions. Isolated ground motion records provide useful information concerning these factors but do not give sufficient data for a clear understanding of the phenomena involved.

What is required are multiple-instrument arrays with configurations tailored to the specific information desired. At the present time, the number of such arrays worldwide is quite small. It is believed that significant improvements in the accuracy of predictions of the nature of strong ground motion will only come as data from such arrays is gathered.

It is important that arrays of strong-motion earthquake measuring instruments be deployed at those worldwide locations which provide the greatest potential yield for the sizeable investment involved. It is also important that such arrays be designed so as to maximize the usefulness of the data which will be obtained. Both of these objectives can best be achieved through a program of international cooperation which draws upon the varied resources of different participating countries. It is with this conviction that the International Association for Earthquake Engineering convened the International Workshop on Strong-Motion Earthquake Instrument Arrays.

^I Professor of Applied Mechanics, California Institute of Technology, Pasadena, California, 91125, U.S.A.

The International Workshop on Strong-Motion Earthquake Instrument Arrays was held May 2-5, 1978 at the East-West Center, Honolulu, Hawaii. The Workshop was sponsored by the United Nations Educational Scientific and Cultural Organization and the United States National Science Foundation. The International Association of Seismology and Physics of the Earth's Interior also passed a resolution stating its close interest in and support of the organization of this Workshop.

Experts in earthquake engineering and seismology from all over the world participated in the Workshop. A list of participants is given in Appendix A. This paper is a report of the conclusions and recommendations of the Workshop and as such represent the product of the combined efforts of all of those in attendance. The full proceedings of the Workshop are contained in reference [1] of this report and a condensed version of the proceedings has been published in reference [2].

The goal of the Workshop was to develop a workable plan for the possible future deployment of dense strong-motion earthquake instrument arrays with primary emphasis on ground motion studies. To this end, the Workshop was organized into subgroups to consider the various aspects of the problem. The subgroup on favorable array locations was chaired by B. A. Bolt, the subgroup on array design for source mechanism and wave propagation studies was chaired by T-L. Teng, the subgroup on array design for local effects was chaired by R. V. Whitman, the subgroup on array construction and operation was chaired by R. B. Matthiesen, and the subgroup on implementation was chaired by G. W. Housner. A brief summary of the findings of each subgroup follows.

FAVORABLE ARRAY LOCATIONS

In compiling a list of promising sites for strong-motion arrays, five principles were employed: 1) the desirability of attaining a high probability of recording detailed strong-motion information for a damaging earthquake ($M > 6.5$) within the next 10 years, 2) the desirability of recording the near field ground motion for a very large earthquake ($M \geq 8$), 3) the desirability of obtaining data from a variety of different source mechanisms and geotectonic conditions, 4) the desirability of favorable operating conditions and 5) the desirability of the proximity of important industrial and population centers with structures of engineering significance.

Application of these principles and a careful examination of potential sites led to the selection of 28 locations as being promising for the deployment of strong-motion arrays. In selecting these sites, consideration was given to return period of earthquakes, the existence of seismic gaps, current seismicity, and the occurrence of large historical earthquakes. The 28 selected sites are indicated in Fig. 1. Table 1 gives an abbreviated description of each of the selected sites and contains some of the data upon which the selection was based. All important source types and a variety of geological conditions is represented. Since the Workshop, major earthquakes have occurred at or near four of the sites selected; E. Tohoku in June 1978 ($M = 7.5$), Gonabad in September 1978 ($M = 7.7$), and Oaxaca in November 1978 ($M = 7.8$) and Yakutat in February 1979 ($M = 7.9$).

Of the 28 locations selected, six were judged to have an especially high probability of yielding useful data within the next few years. The six high priority sites are in order: Shillong, India; Oaxaca, Mexico; Chia-i, Taiwan, Palmdale, U.S.A.; Suruga-Izu, Japan and Varto, Turkey.

The favorable locations indicated by the Workshop were not intended to be exhaustive. Countries throughout the world are encouraged to deploy strong-motion earthquake instruments wherever they believe the conditions for such deployment to be favorable. However, the identified locations were believed to be of sufficient importance that the delegates of the Workshop recommended unanimously that minimal arrays of 10-20 strong-motion instruments be installed immediately at each of these locations. It was further recommended that high priority be given to the design and installation of more elaborate arrays at the six most promising locations. The formal resolution approved by the Workshop delegates is included as Appendix B of this report.

SOURCE MECHANISM AND WAVE PROPAGATION ARRAYS

The ground motion experienced at a given location clearly depends both upon the nature of the earthquake source mechanism and the factors affecting the propagation of waves from the source to the site. In order to gain a fuller understanding of the physical processes involved in this generation and transmission of seismic energy, it will be necessary to obtain data from fairly dense arrays of strong-motion instruments deployed within the near field region of strong earthquakes. These arrays might be expected to have different configurations depending upon the type of source.

Three different source mechanism and wave propagation array configurations were developed by the Workshop participants for possible deployment at favorable sites. For sites with a predominantly strike-slip source mechanism, a comb-shaped surface array was recommended consisting of approximately 100 to 200 instruments. About half of the instruments would be deployed along a line on one side of the fault at an average spacing of approximately 10 km. The remaining instruments would be deployed in a number of legs extending from the fault. These legs would extend linearly from 40-100 km. The line of instruments parallel to the fault should be placed as close as possible to the fault but out of the zone of fault gouge. Most of the instruments extending perpendicular to the fault would be used to measure wave attenuation away from the fault to a distance comparable to the fault depth. Longer legs could be used for the study of path effects.

For sites with a predominantly subduction thrust source mechanism, an array consisting of 50-150 instruments is recommended. It was recommended that these instruments would be arranged in two or three parallel lines along the fault with an average spacing of the order of 20 km. Determination of the source characteristics of a large propagating rupture is of primary interest. However, one or two lines of instruments might be installed perpendicular to the fault in order to study attenuation if this is permitted by the local topography.

For sites with a predominantly dip-slip source mechanism, a two-dimensional array configuration was recommended consisting of

approximately 100 instruments with spacing varying from 2 to 10 km. Intensified clusters of instruments spread over a relatively small area might be used to resolve the characteristics of incident waves for the frequency range of engineering interest.

In addition to the permanent arrays designed for source mechanism and wave propagation investigations, the Workshop recommended that a mobile array of approximately 50 instruments be maintained for possible deployment worldwide to measure the strong ground motion generated by aftershocks following great earthquakes, or to deploy in an area where a significant earthquake event has been predicted. Such an array could be set up in a parking configuration capable of gathering data while being stored for future deployment but should be truly portable. Considerable preplanning will be required if such a mobile array is to be rapidly moved to a promising site. It was believed that the information gained from a number of magnitude 6-7 earthquakes would be extremely valuable in the study of the generation and transmission of seismic waves as well as in the study of local site effects.

It was recommended by the Workshop that instruments used in source mechanism and wave propagation arrays be three-component, 2g accelerometers having a bandwidth of 0.1 to 30 Hz and a dynamic range of 10^6 . Provisions should also be made for precise relative timing. Internal clocks should have a drift rate of less than 10^{-7} and should be externally resettable. All instruments should have pre-event memories and easily adjustable trigger levels.

LOCAL EFFECTS ARRAYS

A complete description of earthquake generated ground motion involves more than the characterization of the motion at a particular point. It also requires the description of the gradients of motion which give rise to possible rocking, twisting and relative motion between different points. The precise nature of the motion will be affected not only by the properties of the source and the wave propagation path between the source and site but also by many local factors. These include: localized topographic and soil features, soil-structure interaction effects, soil liquefaction, etc. The nature of strong earthquake ground motion and the way that it is affected by various local conditions can only be adequately understood if additional data are gathered using a system of local effects arrays.

Four general types of local effects arrays were recommended by the Workshop. These include: Local Laboratory Arrays, Simple Extended Arrays, Elemental Arrays and Special Arrays. Local Laboratory Arrays were envisioned as relatively complex arrays intended to provide data concerning the gradients of ground motion and the nature of wave propagation through a local site. They would consist of from 25 to 40 instruments arranged over an area of up to 1 km^2 and to depths of approximately 100 m. If available, instruments measuring rotational and relative motion should be installed as well as conventional accelerometers. Common time bases and simultaneous triggering would be required. It was believed that these arrays could be successfully deployed in regions where frequent shaking of 0.05g or greater

is expected. They might exist alone or in conjunction with source mechanism and wave propagation arrays.

A major requirement for the siting of Local Laboratory Arrays is that the geological and geotechnical properties of the site and its surroundings be well known and relatively simple. It is also desirable that the site be sufficiently representative of other sites that the data will be useful by direct extrapolation. It was recommended that at least two different types of sites be instrumented if possible: a relatively flat site with uniform material extending to depths of several hundred kilometers, and a relatively flat site with soil ($C_s = 200-500$ m/s) extending to 30-100m and rock thereafter ($C_s > 1000$ m/s).

Simple Extended Arrays are smaller arrays designed to measure systematic variations in ground motion across localized soil, geologic or topographic features. These arrays could consist of from 6 to 12 linear accelerometers having common time bases and triggering but the use of instruments capable of measuring rotational motion if available is also strongly encouraged. Some arrays of this type are currently deployed. Such relatively simple arrays would provide data which could be used to verify existing and future theories on the focusing and dispersion of seismic waves. They might also be used to measure the relative motion experienced by pipelines and similar extended systems.

Elemental Arrays as envisioned by the Workshop are vertical arrays or horizontal clusters of approximately three instruments contained within a limited area. These arrays would provide data on variations of ground motion with distance and depth. Numerous arrays of this type already exist but their deployment should be expanded. Several different configurations for Elemental Arrays may be envisioned. For example, arrays consisting of 3 accelerometers located on the surface at the corners of a triangle with legs approximately 50 m long would provide useful data on local wave propagation effects and local relative motion. Similarly, arrays of 2 instruments in which one was located on rock and the other on nearby soil would provide much needed data on soil amplification effects. Arrays in this category would be relatively easy to design and inexpensive to install.

The Workshop also recommended a number of special arrays. The Special Arrays recommended were of two types; those intended for soil-structure interaction studies and those intended for liquefaction studies. For soil-structure interaction studies the instrumentation of prototype rigid foundations, simple model building structures and extended buried structures was recommended. Rotational accelerometers, strain gauges and pore-pressure transducers would be required for such studies in addition to conventional accelerometers. For liquefaction studies, various levels of instrumentation were recommended. Such arrays should have both accelerometers and pore-pressure transducers installed on the surface and to depths of up to 30 m.

ARRAY CONSTRUCTION AND OPERATION

Several factors affect the cost of construction and operation of a strong-motion array. These include: 1) the availability of field tested instrumentation, 2) local construction and operation capabilities and 3) the availability of data processing and dissemination facilities. Information on current strong-motion programs was used to estimate the costs involved in the major types of arrays recommended herein.

In order to enable cost comparisons, a currently available 12 bit three-component digital accelerograph with a range of 0.001g to 2.0g, a self-trigger and a 2.5 sec pre-event memory was used as the basic instrument for all arrays. The estimated costs involved in deploying a strong motion array are summarized in Table 2. The figures are in 1978 U.S. dollars. The cost figures given for start-up, installation and operation will vary according to the location of the array. The figures given are for California, U.S.A. A site cost adjustment factor is shown in Table 1 for the 28 promising sites selected.

Based on the figures of Table 2, it is seen that a source-mechanism and wave propagation array consisting of 100 instruments would cost approximately \$830,000 to install and would require an annual operating budget of \$80,000. The costs associated with the deployment of a Local Laboratory Array would be lower due to the close proximity of the instruments and the fewer number of data channels involved. It was estimated that an array capable of centrally recording 90 channels of acceleration data from surface and down-hole sensors would cost approximately \$520,000 with an annual operating budget of approximately \$25,000. These figures would increase if instruments such as pore-pressure sensors were added. Cost estimates for Simple Extended, Elemental or Special Arrays may be estimated using the information contained in Tables 1 and 2.

In order to adequately manage the assembling, processing and dissemination of data it was recommended by the Workshop that three regional data centers be established. These centers would be located in North America, Asia, and either Europe or the Middle East. A standard data format should be agreed upon by all centers. The centers should store all earthquake and station information in a telephone accessed computer and bulletins should be circulated every three months describing records obtained. Floppy disks and cassettes should be used for the exchange of individual earthquake records.

IMPLEMENTATION PLAN

The implementation plan recommended by the Workshop was intended to be flexible and was therefore not rigidly defined. It was believed that array programs should be controlled by participating engineers and scientists which would appear to preclude any highly developed international inter-governmental structure at the present time. It was, however, felt that it is possible and indeed beneficial to tie the implementation plan for strong-motion arrays to the International Association for Earthquake Engineering (IAEE).

It was recommended that the IAEE in consultation with other organizations such as the International Association of Seismology and Physics of the Earth's Interior (IASPEI) appoint an International Strong Motion Array Council (ISMAC). This Council would be responsible for the initial organization of the implementation structure and would, among other things, prepare general guidelines for array deployment, recommend priorities for array locations and coordinate the worldwide assembling and dissemination of data.

In order to assist it in its responsibilities, ISMAC would appoint Committees. The Workshop envisioned that these ISMAC Committees would have responsibilities in the following areas: 1) Data Projects, including the preparation of catalogs of existing and future data; 2) Intensive Instrumentation Arrays, including source mechanism and wave propagation arrays; 3) Regional Arrays, including stand alone Local Laboratory Arrays and Simple Extended Arrays; 4) Local Arrays, including Elemental Arrays and Special Arrays; and 5) Mobile Arrays. The proposed organizational structure is presented in Figs. 2 and 3.

It was recommended that a Steering Committee be formed for the planning and execution of each individual array project. This Steering Committee would formulate overall design and operation plans for the array. Such Steering Committees should be encouraged to work closely with the relevant ISMAC Committee thereby optimizing their effort from an international point of view. Where no Steering Committee was established or where such a structure was deemed inappropriate, it was strongly recommended that some other mechanism be found for liaison and information transfer between those responsible for the individual array project and the relevant ISMAC Committee.

The proposed structure recognized that governments, at present, are unlikely to commit a segment of national resources into a general fund to be disbursed under the recommendations of an international panel of engineers and scientists. Thus, the concept of the proposed Council was that of a group formulating specific plans out of the generalized recommendations of the Workshop. The Council and its committees will recommend standards for data acquisition and disbursal, etc. All actual cooperative projects will be organized on bilateral, or multilateral bases; and the selection of projects to be undertaken will, hopefully, conform to the recommendations of the Council or of one of its committees. This implementation structure allows freedom for each country to have clear knowledge of how its resources are being used and to make individual commitments for each project it wishes to join.

PRESENT STATUS OF IMPLEMENTATION

In May of 1979, after soliciting suggestions from the Executive Committee, the President of IAEE made initial appointments to ISMAC. The present members of the Council are: W. D. Iwan (Chairman), B.A. Bolt, A.R. Chandrasekaran, V. Karnik, Y. Osawa, J. Petrovski and J. Prince. The organizational meeting of the Council was scheduled for early in 1980 with a follow-up meeting during the Seventh World Conference on Earthquake Engineering. Bylaws for the operation of the Council have been

drafted and approval should be completed by the time of the World Conference.

The Council office will initially be established in Tokyo in conjunction with the Central Office of IAEE. The latter office operates under the auspices of the Japan Society for the Promotion of Earthquake Engineering which has indicated its willingness to arrange for the expansion necessary to handle Council activity. Once ISMAC becomes a financially viable organization, it may move its headquarters from time to time in the interest of better carrying out its objectives. Until outside funding is secured, the expenses of ISMAC members will be borne by the individuals involved or their respective countries.

At the time of the writing of this report, a strong-motion array is being installed in Taiwan. In addition, proposals are in various stages of consideration for arrays in India and The People's Republic of China. ISMAC has reviewed progress reports on the Taiwan array and has also examined new array proposals. The Council is actively working on the preparation of guidelines for array deployment, the establishing of priorities for array locations and procedures for the coordination of the assembling and dissemination of strong-motion array data. The formation of various ISMAC Committees should be accomplished within the near future.

ACKNOWLEDGEMENTS

The Workshop was sponsored by grants from the National Science Foundation and the United Nations Educational, Scientific and Cultural Organization. Any opinions, findings, and conclusions or recommendations expressed in this paper are those of the delegates as interpreted by the author and do not necessarily reflect the views of the National Science Foundation or the United Nations Educational, Scientific and Cultural Organization.

REFERENCES

1. Iwan, W.D., Ed., "Strong-Motion Instrument Arrays," Proceedings of the International Workshop on Strong-Motion Earthquake Instrument Arrays, May 2-5, 1978, Honolulu, Hawaii.
2. Iwan, W.D., "The Deployment of Strong-Motion Earthquake Instrument Arrays," Earthquake Engineering and Structural Dynamics, Vol. 7, #5, 1979, pp. 413-426.

APPENDIX A

LIST OF PARTICIPANTS

Steering Committee

W. D. Iwan, U.S.A., Chairman	Y. Osawa, Japan
A. S. Arya, India	J. Petrovski, Yugoslavia
G. W. Housner, U.S.A.	J. Prince, Mexico
J. Krishna, India	R. I. Skinner, New Zealand
R. B. Matthiesen, U.S.A.	

Subgroup on Favorable Array Locations

B. A. Bolt, U.S.A., Chairman	T. Mikumo, Japan
A. Udias, Spain, Vice-Chairman	M. Niazi, Iran
L. S. Cluff, U.S.A.	S. I. Sacks, U.S.A.
V. Karnik, Czechoslovakia	L. S. Srivastava, India

Subgroup on Array Design for Source Mechanism
and Wave Propagation Studies

T-L. Teng, U.S.A., Chairman	J. E. Luco, U.S.A.
A. Aki, U.S.A., Vice-Chairman	B. Tucker, U.S.A.
D. Boore, U.S.A.	F. T. Wu, U.S.A.

Subgroup on Array Design for Local Effects

R. V. Whitman, U.S.A., Chairman	L. W. Heller, U.S.A.
L. Esteve, Mexico, Vice-Chairman	Y. Ohsaki, Japan
G. N. Bycroft, U.S.A.	H. Shibata, Japan
E. Faccioli, Italy	J. Christian, U.S.A.
W. J. Hall, U.S.A.	

Subgroup on Array Construction and Operation

R. B. Matthiesen, U.S.A., Chairman	W. R. Stephenson, New Zealand
M. Erdik, Turkey	H. Tsuchida, Japan

Subgroup on Implementation

G. W. Housner, U.S.A., Chairman	J. Krishna, India
Y. Osawa, Japan, Vice-Chairman	T. Okubo, Japan
A. S. Arya, India	J. Penzien, U.S.A.
J. Evernden, U.S.A.	

Observers

W. M. Adams	U.S.A.
K. L. Benuska	U.S.A.
T. Boen	Indonesia
S. Cherry	Canada
A. S. Furumoto	U.S.A.
H. J. Lagorio	U.S.A.
J. F. Lander	U.S.A.
S. C. Liu	U.S.A.
R. P. Maley	U.S.A.
D. Mayer-Rosa	Switzerland
W. A. Minoza	Philippines
A. A. Moïnfar	Iran
N. N. Nielsen	U.S.A.
J. E. O'Connell	U.S.A.
S. Okamoto	Japan
E. Shima	Japan
G. T. Taoka	U.S.A.
C. C. Thiel	U.S.A.
Y. Tsai	Taiwan
T. M. Wooton	U.S.A.
R. Yarar	Turkey

APPENDIX B

Resolution of the International Workshop on Strong Motion Earthquake Instrument Arrays, May 2-5, 1978, Honolulu, Hawaii, USA

The protection of life and property from the devastating effects of earthquakes is an urgent worldwide problem. An understanding of the nature of strong earthquake motions is of crucial importance in solving this problem. At the present time, however, there is a scarcity of engineering data acquired near the centers of destructive earthquakes, and existing instrument arrays are inadequate to provide the necessary data. Yet there is a high probability of occurrence of destructive earthquakes in different parts of the world in the next decade. The participants in this international workshop unanimously recommend that the earthquake-threatened countries and other concerned countries and organizations make a concerted effort to establish a comprehensive worldwide system of specialized strong-motion earthquake instrument arrays capable of resolving the nature of the earthquake source mechanism, wave propagation and local site effects. As a first step, the following specific recommendations should be implemented.

1. The International Association for Earthquake Engineering in collaboration with the International Association for Seismology and Physics of the Earth's Interior form an International Strong Motion Arrays Council to facilitate the establishment of strong-motion earthquake instrument arrays.
2. Earthquake-threatened countries individually and collectively initiate the immediate installation of minimal arrays of 10-20 strong-motion instruments at least at the 28 worldwide sites identified by this workshop.
3. High priority be given to the design and installation of more elaborate source mechanism, wave propagation and local effects arrays, particularly at the 6 critical sites identified.
4. A mobile strong-motion instrument array capable of making source mechanism, wave propagation and local effects measurements be established and maintained for deployment immediately following the occurrence of a major earthquake for the recording of aftershocks.

TABLE 1
FAVORABLE ARRAY LOCATIONS

Source Type	Country	Area (Fault)	Nearby Maximum Feasible Earthquake Magnitude	Nearby Maximum Historical Earthquake Magnitude and Intensity	Trigger Probability Per 10 Yrs. Acc > 0.2g M > 6.5	Site Cost Factor
S	Argentina	San Juan (San Juan)	7.5	7. 1944 X	.2	1.5
S	Bulgaria/Yugoslavia	Struma	7.75	7.75 1904 X	.2	1.25
TS	Canada	Vancouver Is. (Queen Charlotte)	8+	7.3 1946	.3	1.0
T	Chile	Arica	8+	8.5 1868	.5	2.0
S	China	Shantung	8+	8.5 1668	.1	1.0
T	Guatemala	Antigua	8.5	8.3 1902	.7	2.5
S	Greece	Patras (Nearby)	7.5	7. 1953 X	.5	1.5
TS	India	Shillong (Dauki-Hailong)	8.7	8.7 1897 XII	.8	1.5
T	Indonesia	Western Java (Sumatra?)	8	8.1 1903	.2	2.5
S	Iran	Gonabad (Dasht-e-Bayaz)	7.5	7.3 1968 X	.2	1.5
TS	Iran	Teheran (North-Teheran)	8	7.2 1962 X	.2	1.0
N/R	Italy	SW Calabria	7.5	7.3 1905 X	.2	1.25
TS	Japan	Eastern Tohoku (Nearby)	8	7.9 1968	.3	1.25
TS	Japan	Suruga Bay-Izu (Nearby)	8	8.4 1854	.4	1.0
S	Japan	Western Chubu (Neodani)	8	7.9 1891	.2	1.0
T	Mexico	Oaxaca	8.5	8.5 1903	.9	2.0
N/R	New Zealand	Wellington (Wellington)	8+	8.5 1848	.1	1.25
T	Peru	Ica	8+	8.1 1942	.4	2.0
S	Philippines	Quezon (Luzon)	8.5	8.1 1897	.6	2.0
N/R	Spain	Granada (Nearby)	7.0	7. 1884 X	0.1	1.0
S	Taiwan	Chiyai (Meitzekeng)	7.5	7.1 1941 IX	.9	1.0
S	Turkey	Adapazari (N. Anatolian)	8+	7.1 1967 IX	.4	1.0
S	Turkey	Varto (N. Anatolian)	8	8.0 1939	.6	1.5
S	USA	Palmdale, CA (San Andreas)	8.5	8.4 1857 X	.3	1.0
N/R	USA	Salt Lake, Utah (Wasatch)	8	7.2 1932 VIII	.1	1.0
T	USA	Yakutat, Alaska (Fairweather)	8.5	8.5 1899	.6	3.0
S	USSR	Garm (Nearby)	7.5	7.25 1949	.2	1.0
T	USSR	S. Kamchatka	8.5	8.4 1952	.4	2.0
	Peru ¹	Cordillera	7.5	7+ 1960	(.8)	

LEGEND

Source Type: T = thrust N/R = vertical motion
 S = strike slip (normal/reverse)
 SZ = subduction zone
 I = intraplate

NOTES

1. This site is one suggested as particularly promising for location of a mobile strong-motion array capable of rapid field deployment to a region of aftershocks.

TABLE 2

<u>Category</u>	<u>Cost Per Array</u>	<u>Cost Per Installation</u>
1. <u>One Time Start-Up Costs</u>		
Site investigations	\$ 10,000	
Facilities, test and repair equipment	<u>\$120,000</u>	
Total cost per array	\$130,000	
2. <u>Instrumentation and Installation Costs</u>		
Instruments (12 bit, 3-comp. accelerographs)		\$5,000
Site preparation and installation		<u>\$2,000</u>
Total cost per instrument		\$7,000
3. <u>Annual Operating Costs</u>		
Total per instrument		\$800

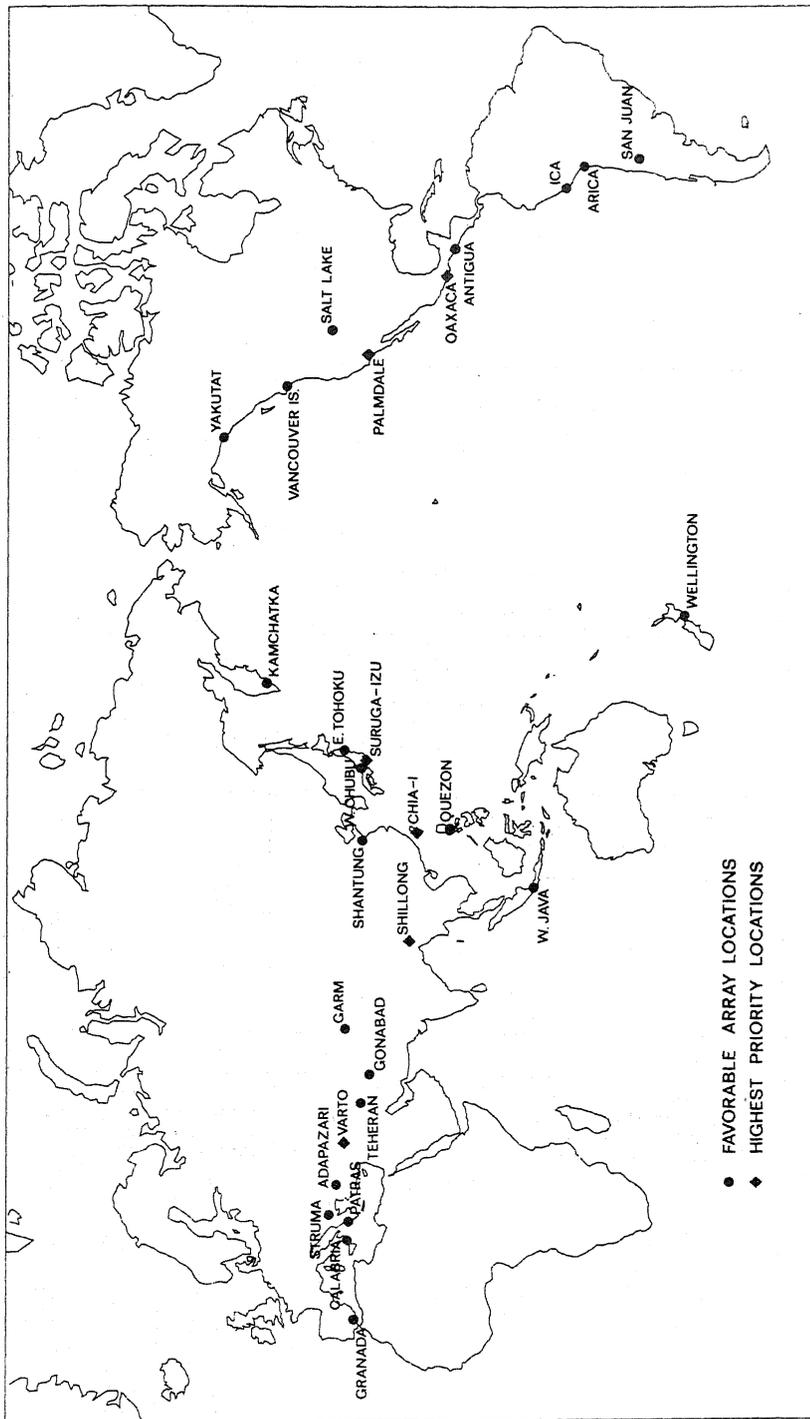


Figure 1

Implementation Structure

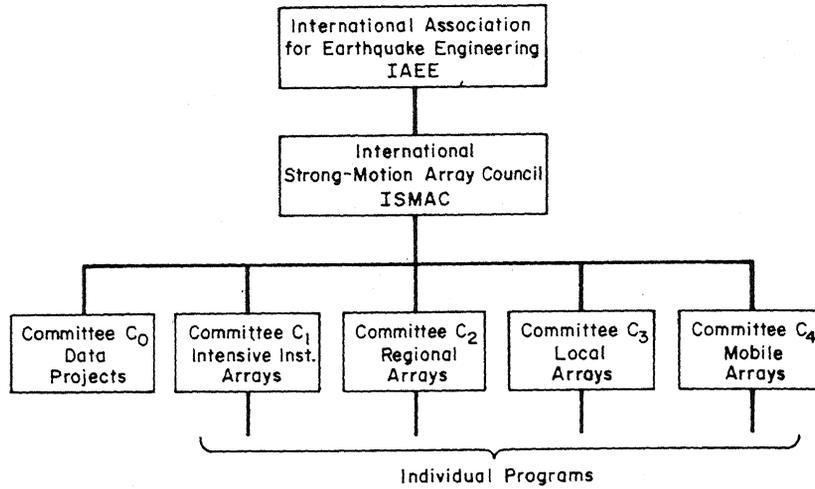


Figure 2

ISMAC Committee Structure (Typical)

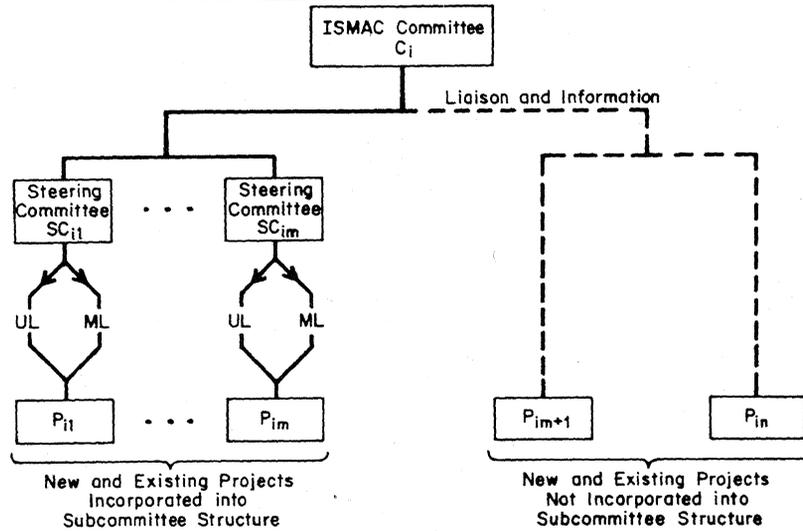


Figure 3